REMARKS

/I/ Amendments to the claims

Upon entry of the present amendment, claims 1, 3, 5, 7-14 and 16 will remain pending in the above-identified application, with claims 1, 3, 5 and 14 standing ready for further action on the merits, and remaining claims 7-13 and 16 being withdrawn from consideration based on an earlier restriction requirement of the Examiner. Claims 1 and 14 have been amended and claim 15 has been cancelled.

Amendments to Claim 1:

Claim 1 of the present invention has been amended. Specifically, the following amendments have been made.

The pencil hardness has been changed from "H or higher" to -- 2H or higher --. Support for this amendment is found, for example, in Table 1 on page 108 of the present specification.

The drying and curing conditions have been limited to -- at a temperature of from 80 to 120 °C for 15 minutes or less --. Support for this amendment is found at page 64, lines 19-21 and page 65, lines 16-17 of the present specification.

Amendments to Claim 14:

The silica-containing laminated structure in this claim has been amended so as to be in conformity with claim 1.

Accordingly, the present amendments to the claims do not introduce new matter into the application as originally filed. As such entry of the instant amendment and favorable action on the merits are earnestly solicited at present.

/II/ <u>Rejections under 35 U.S.C. §103(a)</u>

In the outstanding Office Action dated July 30, 2010, the USPTO has maintained the rejection of claims 1, 3, 5, 14 and 15 under 35 U.S.C. 103(a) as being unpatentable over **Lange** (US 4,816,333) in view of **Takahashi** (US 6,251,523). Specifically, the USPTO states as follows:

> *...It would have been obvious to one of ordinary skill in the art to modify Lange's coating with Takahashi's chain silica particles, motivated by the desire to obtain a coating with an improved low reflectance approaching zero, i.e., an improved antireflection.*

Further, the USPTO states that all the features of the present invention can be achieved through obvious routine optimization. Specifically, the USPTO states as follows.

> *...Regarding the hardness, minimum reflectance and the equation describing the structural relationship between various structural elements of the coating, since the collective teachings of prior art render the general structure, composition, and process of making the claimed invention obvious, these properties are deemed to be obvious routine optimizing to one skilled in the art, motivated by the desire to obtain required properties for the same end use as the claimed invention.*

The rejection is respectfully traversed and reconsideration and withdraw of the same is respectfully requested based on the following considerations.

(II-1) Legal Standard for Determining Prima Facie Obviousness

M.P.E.P. § 2141 sets forth the guidelines in determining obviousness. First, the USPTO has to take into account the factual inquiries set forth in *Graham v. John Deere*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966), which has provided the controlling framework for an obviousness analysis. The four *Graham* factors are:

(a) determining the scope and content of the prior art;

(b) ascertaining the differences between the prior art and the claims in issue;

(c) resolving the level of ordinary skill in the pertinent art; and

(d) evaluating any evidence of secondary considerations.

Graham v. John Deere, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966).

Second, the USPTO has to provide some rationale for determining obviousness. MPEP § 2143 sets forth some rationales that were established in the recent decision of *KSR International Co. v Teleflex Inc.*, 82 USPQ2d 1385 (U.S. 2007). Exemplary rationales that may support a conclusion of obviousness include:

(a) combining prior art elements according to known methods to yield predictable results;

(b) simple substitution of one known element for another to obtain predictable results;

(c) use of known technique to improve similar devices (methods, or products) in the same way;

(d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;

(e) "obvious to try" – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success

(f) known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;

(g) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

As the M.P.E.P. directs, all claim limitations must be considered in view of the cited prior art in order to establish a *prima facie* case of obviousness. *See* M.P.E.P. § 2143.03.

(II-2) Features of the Present Invention

As mentioned in section /I/ above, claim 1 of the present application has been amended. As can be seen from amended claim 1, the present invention is directed to a silica-containing laminated structure comprising a transparent thermoplastic resin substrate and, laminated thereon, at least one porous silica layer which satisfies the structural relationships expressed in formula (1) and has the following properties:

- refractive index of 1.22 or more and less than 1.30, and
- pencil hardness of 2H or higher as measured in accordance with JIS K5400 under a load of 1 kg, using a testing pencil as defined in JIS S6006.

That is, the porous silica layer simultaneously exhibits a desirably low refractive index and a high mechanical strength.

As also can be seen from amended claim 1, such a porous silica layer is formed by a method comprising:

(1) providing a coating composition comprising a product obtained by a method comprising:

mixing a dispersion of moniliform silica strings with a hydrolyzable group-containing silane to obtain a mixture, and

subjecting the obtained mixture to hydrolysis and dehydration-condensation, and

(2) applying said coating composition on a substrate, followed by drying and curing at a temperature of from 80 to 120 °C for 15 minutes or less.

That is, the hydrolysis and dehydration-condensation of the silane should be done in the presence of the moniliform silica strings in preparation of the coating composition, and the coating composition applied to the resin substrate should be dried and cured at a low temperature for a short time.

This specific process has for the first time enabled the formation of the porous silica layer (antireflection film) simultaneously exhibiting the above-mentioned excellent properties using the moniliform silica strings.

(II-3) Background of the Present Invention

As described under the section "Prior Art" of the present specification, a single-silica-layer antireflection film for coating for a conventional transparent substrate having a refractive index of from 1.49 to 1.67 is desired to exhibit a specific low refractive index (1.22 or more to less than 1.30). Such an antireflection film is porous and, hence is likely to become fragile; however, needless to say, if the mechanical strength of an antireflection film is poor such that the antireflection film is easily broken or scratched, such a film cannot be put into practical use even if the film exhibits a desired low refractive index. Therefore, the antirefrecltion film is also required to have a satisfactorily high mechanical strength.

Further, as described at page 7, line 23 to page 8, line 3 of the present specification, it is easy to produce a single-silica-layer film having a low refractivity from silica particles having low density; however, such low-density silica particles have poor strength, so that the strength of the single-silica layer film produced therefrom becomes inevitably poor. Likewise, as can be easily understood, it is relatively easy to produce a silica film which has a low density (high porosity) and has a low refractivity; however, the strength of such a film becomes inevitably

poor. This is especially true in the case where an antireflection film is formed on a resin substrate and the high temperature sintering to enhance the strength cannot be carried out.

Thus, as far as an antireflection film formed on a resin substrate is concerned, there has been a trade-off between the refractive index and the mechanical strength, and it has conventionally been impossible to produce a single-silica-layer antireflection film which not only has a desired low refractive index (1.22 or more to less than 1.30) but also has a satisfactory mechanical strength (2H or higher in accordance with JIS K 5400).

(II-4) Distinctions Over the Cited Art References

For forming a silica film on a glass substrate, **Takahashi** uses the chain silica fine particles so as to increase the pore volume ("void ratio") of the silica film by utilizing the specific three-dimensional structure of the chain silica fine particles. As discussed in more detail below, this increase in the pore volume ("void ratio") naturally poses the problem of lowering of the mechanical strength due to the sparse structure formed by the chain silica fine particles. **Takahashi** teaches that this problem can be solved by the sintering carried out at a very high temperature for a very long time (col. 7, lines 31-34), and it can be easily understood that such sintering is actually carried out in the Examples of Takahashi for this very reason.

As already mentioned in the previous response of the Applicants, in all of the Examples of **Takahashi**, a coating composition is prepared by a method in which the "chain silica colloid" (moniliform silica strings) is mixed with the "hydrolytic condensation polymerization liquid of ethyl silicate", which means that the hydrolyzable group-containing silane (ethyl silicate) has been subjected to hydrolysis and dehydration-condensation prior to mixing thereof with moniliform silica strings.

The results of the Examples of **Takahashi** show that the refractive index of the silica film decreases as the void ratio increases. In the "Sixth Embodiment", the void ratio is the highest (70 %) and the refractive index is the lowest (1.28) (*see* TABLE 9 on col. 16 of **Takahashi**). Specifically, the relationship between the void ratio and the refractive index in the Examples of **Takahashi** is as follows.

	Seventh Embodiment		First Embodiment		Sixth Embodiment
Void ratio (vol%)	55	<	60	<	70
Refractive index	1.38	>	1.340	>	1.28

Note: The data shown here have been excerpted from TABLE 3 on col. 10-11 and TABLE 9 on col. 16 of ***Takahashi***

As apparent form this Table, only in the "Sixth Embodiment" (where the void ratio is the highest, 70 vol%) among the Examples of **Takahashi**, the refractive index as required in the present invention (1.22 or more and less than 1.30) is achieved.

Thus, from the Examples of **Takahashi**, it can be deduced that the refractive index (more than 1.22 to less than 1.30) as required in the present invention cannot be achieved unless the void ratio is about 70 vol% (highest value in the Examples of **Takahashi**) or higher. As pointed out by the Examiner, **Takahashi** suggests that the high temperature sintering for improving the mechanical strength is optional; however, one of ordinary skill in the art would naturally understand that a high temperature sintering is indispensable to secure the mechanical strength of the sparse structure (having a void ratio of 70 vol%) formed by the chain silica fine particles.

In fact, as already mentioned in the previous response of the Applicants, in each of Comparative Examples 2 and 3 of the present application (page 85, line 24 to page 88, line 8 of the present specification), a hydrolyzable group-containing silane is subjected to hydrolysis and dehydration-condensation prior to mixing thereof with moniliform silica strings as in the Examples of **Takahashi**. As a result, the refractive index is satisfactorily low ("1.27" in Comparative Example 2 and "1.29" in Comparative Example 3); however, the mechanical strength is poor (pencil hardness "H" in both of Comparative Examples 2 and 3).

On the other hand, in all of Examples 5 to 9 which are carried out under conditions similar to those in Comparative Examples 2 and 3 except that the hydrolysis and dehydration-condensation are carried out in the presence of the moniliform silica strings, the obtained porous silica layer exhibited not only a desired low refractive index ("1.27" or "1.29") but also a high mechanical strength (pencil hardness "2H").

Needless to say, generally, a lower refractive index of a silica film generally means higher porosity and less strength of the silica film. Therefore, it is very surprising and unexpected that the silica film of the present invention has a very low refractive index (1.22 or more to less than 1.30) but still exhibits a pencil hardness of 2H or higher. Since the pencil hardness of an antireflection film formed of silica particles is generally about 3H at the highest, the difference between "H" and "2H" is of a great significance in commercial use of the antireflection film. In the art, great effort has been made to improve the pencil hardness of the antireflection film by one degree around 2H, e.g., from H to 2H.

In this connection, the Applicants submit herewith the following documents for reference:

<u>Exhibit 1</u>: US 7,233,378 (Priority date: February 1, 2002)

<u>Exhibit 2</u>: US 7,659,352 (Priority date: November 11, 2004)

<u>Exhibit 3</u>: On-line document available at:

http://www.kimoto.co.jp/products/electronics/kb.html

(and a partial English translation thereof).

As can be seen from **Exhibit 1**, in all of the Examples of this reference, a "low refractive index layer" is produced from silica particles and this layer exhibits a refractive index of <u>1.40</u> (col. 25, lines 39-51, and col. 26, lines 21-27). As shown in Table 1 on col. 28, such a "low refractive index layer" has a pencil hardness (JIS K 5400) of <u>3H</u>.

Further, in the Examples of **Exhibit 2**, antireflection films are formed from a combination of a silane and a colloid silica or from a polymerizable colloid silica (col. 5, line 35 to col. 8, line 41). As can be seen from Table 1 on col. 10, when the refractive index is the lowest (i.e., <u>1.37</u>), the antireflection films have a pencil hardness (JIS K 5600) of <u>H</u>. In this connection, as apparent from **Exhibit 3**, the relationship between the pencil hardness levels of the same sample according to JIS K 5400 and JIS K 5600 is: the hardness level according to JIS K 5400 is equivalent to or slightly higher than the hardness level according to JIS K 5600. Therefore, the pencil hardness "H" (JIS K 5600) in the Examples of **Exhibit 2** corresponds to the pencil hardness of "H" or "2H" (JIS J 5400) in the present invention.

Thus, it is apparent that the difference in the pencil hardness between "H" and "2H" is of a great significance in practical use of an antireflection film.

From the above, it is apparent that **Takahashi** has <u>no</u> teaching or suggestion that the above-mentioned problem of trade-off between the refractive index and the mechanical strength

can be solved by the use of the chain silica fine particles especially when the high temperature sintering should be omitted.

As to the timing of the hydrolysis and dehydration-condensation, the Examiner may argue that, when considering to combine **Lange** and **Takahashi**, it may be obvious to try another alternative, i.e., the hydrolysis and dehydration-condensation of the silane in the presence of the chain silica fine particles (col. 4, line 66 to col. 5, line 24 of **Takahashi**), if a satisfactory strength is not obtained when the chain silica fine particles are added after hydrolysis and dehydration-condensation. However, **Takahashi** has no teaching or suggestion that a desired low refractive index can be achieved even in the case of the hydrolysis and dehydration-condensation in the presence of the chain silica fine particles and even while omitting the high temperature sintering and still preventing the lowering of the mechanical strength.

To the contrary, one of ordinary skill in the art would consider that, if the mechanical strength can be improved when the hydrolysis and dehydration-condensation are carried out in the presence of the chain silica fine particles, this in turn means that the void ratio has decreased and, hence, the refractive index of less than 1.30 (which is achieved only with the highest void ratio, 70 vol%, in the Examples of **Takahashi**) would not be achieved. This should be the reasonable consideration in view of the relationship between the porosity (void ratio) and the refractive index in the Examples of **Takahashi** as explained above and the common general knowledge in the art about the relationship between the porosity (void ratio) and the mechanical strength.

In this connection, attention is drawn to the fact that **Lange** also teaches that a large open porosity is advantageous for lowering the refractive index of the silica coating, but too large an open porosity weakens the coating (col. 4, lines 10-15).

In addition, **Takahashi** gives the following formula on the relationship between the refractive index (RI) and the open porosity (Po) at col. 4, line 45:

$$RI = \frac{Po}{100} + \left(\frac{100 - Po}{100}\right)1.47$$

According to this formula, the lowest refractive index "1.28" in the Examples of **Takahashi** is supposed to be achieved in **Lange** when the open porosity is about 40 %. However, as mentioned above, this refractive index "1.28" is achieved in **Takahashi** only when the void ratio is as high as 70 vol%.

The **Lange**'s formula is only theoretical as proved by Mr. Nakatani's Declaration filed on February 27, 2008 (which also shows that the refractive index achievable by **Lange** is in fact much higher that the range required in the present invention), and the "open porosity" in **Lange** and the "void ratio" in **Takahashi** may not be exactly the same; however, the fact remains that the **Lange**'s formula clearly teaches that the refractive index "1.28" can be achieved with the pore volume of as low as about 40 %, whereas the Examples of **Takahashi** clearly teach that the same refractive index cannot be achieved by **Takahashi** unless the void ratio is increased to as high as 70 vol%. Then, why would one of ordinary skill in the art be motivated to use the chain silica fine particles of **Takahashi** in place of the **Lange**'s silica particles regardless of an obvious risk of serious lowering of the mechanical strength due to the very high pore volume even without any improvement of refractive index? In addition, **Takahashi** has no teaching or suggestion that the coating of **Takahashi** can maintain a satisfactory mechanical strength even when the high temperature sintering is omitted.

From the above, it is apparent that **Takahashi** has <u>no</u> teaching or suggestion that the use of moniliform silica strings can solve the above-mentioned trade-off between the refractive index and the mechanical strength of an antireflection film formed on a resin substrate, and the collective teachings of **Lange** and **Takahashi** rather <u>discourage</u> one of ordinary skill in the art from combining the chain silica fines particles of **Takahashi** with the resin substrate of **Lange**.

For cautions' sake, it should be reminded that, though Mr. Nakatani's declaration filed on February 27, 2008 shows that the refractive index and the hardness as required in the present invention cannot be achieved by **Lange**, Mr. Nakatani's Declaration is based on the later observations and experiments; therefore, the teaching of this Declaration of course would not constitute the prior art, and the obviousness of the invention over **Lange** and **Takahashi** should be evaluated exclusively based on what are disclosed in these prior art references. The above-mentioned RI-PO relationship formula of **Lange** clearly suggests to the reader the possibility of achieving the refractive index "1.28" with the pore volume of as low as about 40 %, whereas later in 2008, Mr. Nakatani's Declaration has for the first time proved that the formula is only theoretical and does not reflect the reality.

Furthermore, as already pointed out in the Applicants' previous response, **Lange** clearly teaches that the agglomeration of silica particles used for preparing a coating composition should be <u>avoided</u> as apparent from the following description:

> "The colloidal solution, <u>finely divided</u> solid silica particles of <u>ultramicroscopic size</u> in a liquid, utilized in the present invention, may be <u>acid stabilized, sodium stabilized, or ammonia stabilized</u>. It is <u>especially helpful</u> to acidify sodium stabilized silica sols to a pH of about 3.5 to 4.0, e.g., with glacial acetic acid, to <u>prevent particle agglomeration</u> prior to preparation of the coating solution when alcohol is used as a diluent." (col. 5, lines 28 to 36 (emphasis added))

Needless to say, the chain silica fine particles used in **Takahashi** for preparing the coating composition are agglomerates. Therefore, it is apparent that **Lange** teaches away from the use of chain silica fine particles.

In summary, the present invention is not obvious over the combination of **Lange** and **Takahashi** for the following reasons:

- One of ordinary skill in the art would not have had a "reasonable expectation of success" in replacing the silica particles used in **Lange** with the chain silica fine particles of **Takahashi**, because **Lange** and **Takahashi** collectively teach that the substitution of the silica particles of **Lange** with the chain silica fine particles of **Takahashi** would cause a serious lowering of the mechanical strength of the resultant silica film when formed on a resin substrate by heating at a low temperature for a short time.
- **Lange** teaches away from the use of chain silica fine particles which are agglomerates.

Thus, neither **Lange** nor **Takahashi** teaches or suggests that the above-mentioned problem of the trade-off between the refractive index and the mechanical strength of an antireflection film formed on a resin substrate can be solved by substituting the silica particles of **Lange** with the chain silica fine particles of **Takahashi**.

It is believed that the instant amendments to the claims and the above discussion have clarified the nonobviousness of the present invention over **Lange** in view of **Takahashi**.

In view of the foregoing, the Applicants believe that the pending application is now in condition for allowance. A Notice of Allowance is earnestly solicited.

CONCLUSION

Based upon the amendments and remarks presented herein, the USPTO Examiner is respectfully requested to issue a Notice of Allowance clearly indicating that each of the pending claims 1, 3, 5 and 14 is allowable under the provisions of Title 35 of the United States Code.

Should there be any outstanding matters that need to be resolved in the present application, the USPTO Examiner is respectfully requested to contact John W. Bailey, Reg. No. 32,881 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: January 30, 2010

Respectfully submitted,

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Attachments:

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